Clinical Update

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All-ceramic inlays and onlays

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Introduction

Patients often demand esthetic posterior restorations forcing the restorative dentist to utilize alternatives to traditional direct or indirect metallic restorative materials. Current porcelain systems provide outstanding esthetics and sufficient strength to be considered for many posterior applications. This clinical update reviews the various aspects of all-ceramic inlays and onlays: pre-treatment case evaluation, tooth preparation, provisionalization, system selection, and restoration delivery.

Introduction

Ceramic is defined as nonmetallic and inorganic materials formed after baking at high temperatures.[1] The term "ceramics" is derived from the Greek word "keramos" meaning "burnt stuff." Porcelain is a specific type of ceramic composed of 3 naturally occurring minerals: clay, quartz, and feldspar. These 3 minerals compose what is known as "whiteware," so named because their color is white after baking. Porcelain is a type of whiteware that has relatively high strength and translucency.[2]

History [2,3]

- 1886: First all-ceramic crowns and inlays introduced by Land.
- 1965: McLean and Hughes developed alumina core material to strengthen dental porcelain.
- 1971: Duret was first to consider the automatic production for dental restorations (CAD/CAM technique).
- 1980: Mormann and Brandestini developed chairside CAD/CAM system for machining dental porcelain (CEREC®.
- 1985: Sadoun developed the alumina infiltrated glass techinique (In-Ceram®).
- 1990: Wohlwend and Scharer reported on a technique for pressed glass restorations (Empress®).

Advantages and disadvantages

Advantages of porcelain include esthetics (more life-like, translucent optical properties than resin), durability, biocompatibility, etchability (ability to be bonded), better wear resistance, color control and stability (compared to resin), and thermal conductivity similar to tooth structure. Disadvantages include its potential to cause abrasive wear on opposing tooth structure, risk of fracture, brittleness, technique sensitivity, higher laboratory costs, repair difficulties, and multiple appointments (unless using CAD/CAM system).[3]

Indications and contraindications (Porcelain vs. composite)

The main indication for all-ceramic inlays/onlays is situations where esthetics is the primary concern. When the faciolingual width of the cavity preparation is larger than one-third the intercuspal distance, a porcelain inlay is indicated over resin composite. Porcelain onlays should be utilized when replacing cusps since cuspal coverage with resin composite is contraindicated.[4, 5]

Contraindications to porcelain inlays/onlays include heavy occlusal forces, inability to maintain a dry field, and deep subgingival preparations. Fuzzi and Rapelli found that over 11.5 years, the survival rate of porcelain inlays was higher in premolars (99%) than in molars (90%).[6] Porcelain fracture was the number one reason for restoration failure. [7,8] Therefore, one must avoid heavy occlusal contacts on porcelain inlays/onlays to enhance restoration longevity.

Preparation design (Figure 1)

1. 1.5-2.0mm pulpal floor depth.
2. 1.0-1.5 mm axial reduction.
3. 2.0 mm isthmus width.
4. 1.5-2.0 mm occlusal reduction.
5. Rounded internal line angles.
6. Butt-joint margins.
7. No undercuts.
8. Proximal walls flared 10-12º (6º each wall).

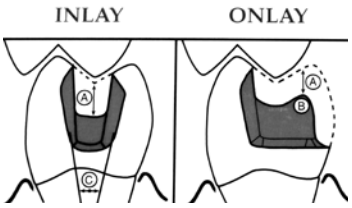

Figure 1. Preparation design for porcelain inlay/onlay: A. 1.5-2.0 mm occlusal reduction; B. Round all internal line angles; C. Proximal walls flared 10-12º. *Diagram courtesy of Glidewell Laboratories.*[9]

It's important to diverge proximal walls 10-12º (twice as much as standard crown preparation walls- 3º each wall) and provide enough tooth reduction to allow for adequate thickness of porcelain (1.5 mm). Thin porcelain is more likely to fracture. There is no benefit to placement of bevels at the occlusal or gingival margins, and bevels should be avoided because inlays are susceptible to chipping at try-in or cementation stages. Since fracture is the number one reason for failure, if the occlusal margin of an inlay preparation is in direct contact of opposing occlusion, it is better to extend the preparation into an onlay. If caries forces the preparation depth greater than 1.5 mm, then place a glass ionomer/resin modified glass ionomer base, e.g. FUJI IX ™ (self-cured), and prepare an ideal porcelain preparation. A dentin shade (stump shade) should be provided to the lab along with the desired porcelain shade.

Provisionalization

Porcelain inlay/onlay preparations can be provisionalized using a material like Systemp.inlay® (formerly known as FERMIT) and Systemp.onlay® (formerly known as FERMIT N). Place Systemp.inlay/onlay® into the preparation and polymerize using a curing light. No temporary cement, e.g. Tempbond or Dycal ®, is needed. At the delivery appointment, Systemp.inlay/onlay® provisional can be easily removed with an explorer. Conventional

materials (e.g. Integrity™, MaxTemp®, Jet®, etc.) can also be used and cemented in the normal manner. For preparations lacking significant retention/resistance form, cement provisionals with polycarboxylate cement (e.g. Durelon™). Mechanical undercuts placed in the internal surface allow the cement to lock into the provisional improving retention.

Material options

- Feldspathic porcelain (porcelain used for PFM crowns). This is the weakest porcelain and most abrasive to natural teeth. Not the first choice for all-ceramic inlays / onlays.
- Heat-pressed ceramic materials, e.g. IPS Empress II®. This leucite-reinforced feldspathic porcelain has improved flexural strength, fracture resistance, and excellent marginal adaptation.
- Infiltrated ceramic materials, e.g. In-Ceram®. These have aluminous cores that are infiltrated with glass to achieve high strength substructure. In-Ceram® has a high flexural strength but cannot be etched, and therefore cannot be bonded. In-Ceram® manufacturers state that both resin and glass ionomer cements can be used for cementation.
- CAD/CAM materials, e.g. CEREC® system. Computer-aided design and computer aided manufacture system has been gaining popularity due to its ability to deliver restoration in one appointment. A disadvantage is its high cost. CEREC® stands for CEramic REConstruction.

Delivery

Preliminary inspection

- Check the fit of inlay/onlay on dies.

Try-in

- Remove the provisional and thoroughly clean the preparations.
- Try-in restoration. Use Pick 'N Stick ™ to avoid dropping the porcelain inlay/onlay. Verify fit and shade. Check and adjust interproximal portion of restoration. **Do not check the occlusion at this time.**

Cementation

- Use rubber dam isolation.
- Clean the teeth with pumice. Wash and dry.
- Etch the internal surface of the inlay/onlay with hydrofluoric acid for 5 minutes if etch was not completed by the lab. Rinse and dry.
- Paint silane onto the etched porcelain to enhance adhesion of the resin. Allow to air-dry.
- Place matrix interproximally to protect adjacent teeth. Mylar can be too thick. Consider dead soft metal matrix or plumber's teflon tape.
- Etch the tooth with 37% phosphoric acid for 15 seconds. Rinse thoroughly and dry.
- Following the manufacturer's instructions for cementing inlay/onlay, apply bonding agent to etched tooth surface and to the restoration.
- Apply dual-cure resin luting agent (e.g. Nexus II®) to the restoration. Be careful to avoid trapping air.
- Gently position the inlay/onlay until fully seated. Remove excess luting agent with an instrument or a brush.
- Hold restoration in place while light-curing the resin cement.
- Remove excess cement before full cure, but be careful not to pull cement out from the margins leaving a defect.
- Light cure for 40-60 seconds from several directions for 2-3 cumulative minutes.

Finishing

- Remove resin flash with a scalpel or sharp curette.
- Check and adjust occlusion.
- Finish accessible margins and occlusion with fine diamonds, using water spray.
- Polish adjusted areas with an intra-oral porcelain polishing system (rubber wheels or points, diamond polishing paste, Dialite ™ kit, etc.) **Remember: for pressable systems, e.g. IPS Empress®, much of the restoration color comes from the application of surface stains which can be polished away.**

Maintenance

- Patients should be instructed to use a soft toothbrush with rounded bristles, and to floss daily.
- Patients should also avoid biting on hard objects/food with restored teeth.

Conclusion

Ceramic inlays and onlays represent a good alternative for the esthetic restoration of posterior teeth. The longevity of these restorations depends greatly on operator attention to detail, but when properly indicated and executed, ceramic inlays and onlays can predictably last as long as 8 years or more.[10]

References

1. Rosenblum MA, Schulman A. A review of all-ceramic restorations. J Am Dent Assoc. 1997 Mar;128(3):297-307.
2. Santulli GA. NPDS Fixed Prosthodontics Syllabus. 2003;170-181.
3. al-Wahadni A, al-Dwairi ZN, Rashid S. History, development and clinical success of porcelain inlays. J Ir Dent Assoc. 2000;46 (2):49-54.
4. Ferracane JL. Using posterior composites appropriately. J Am Dent Assoc. 1992 Jul;123(7):53-8.
5. ADA Council on Scientific Affairs, ADA Council on Dental Benefit Programs. Statement on posterior resin-based composites. J Am Dent Assoc. 1998 Nov;129(11):1627-8.
6. Fuzzi M, Rappelli G. Ceramic inlays: clinical assessment and survival rate. J Adhes Dent. 1999 Spring;1(1):71-9.
7. Hayashi M, Tsuchitani Y, Kawamura Y, Miura M, Takeshige F, Ebisu S. Eight-year clinical evaluation of fired ceramic inlays. Oper Dent. 2000 Nov-Dec;25(6):473-81.
8. van Dijken JW, Hasselrot L, Ormin A, Olofsson AL. Restorations with extensive dentin/enamel-bonded ceramic coverage. A 5 year follow-up. Eur J Oral Sci. 2001 Aug;109(4):222-9.
9. Glidewell Laboratories' Restorative Selection Guide.
10. Ritter AV, Nunes MF. Longevity of ceramic inlays/onlays: Part II. J Esthet Restor Dent. 2003;15(1):60-3.

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